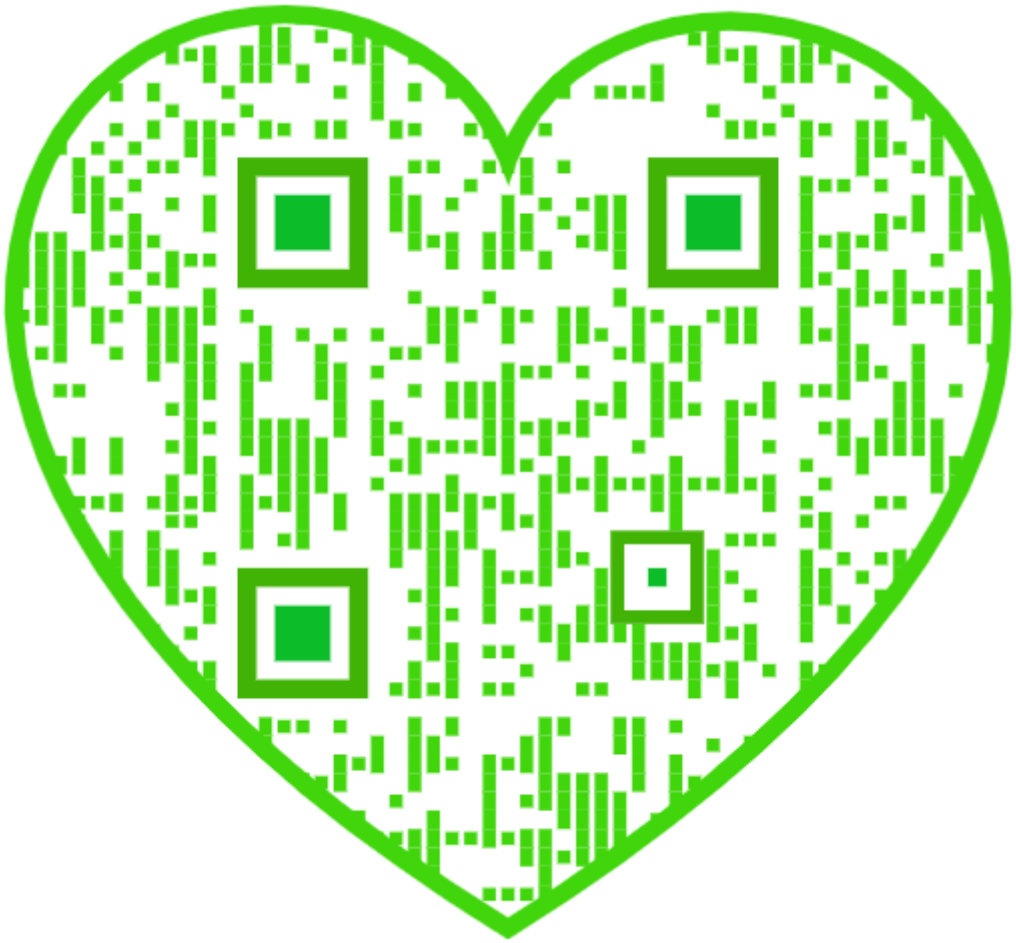

THE

POTATO **PROBLEM** SOLVED.

THE

CAUSE

OF

DISEASE IN THE POTATO POINTED OUT;

REMEDIES EXEMPLIFIED;

AND

NEW SYSTEMS OF POTATO CULTIVATION PROPOSED.

BY

ROBERT ARTHUR,

AT MESSRS. DICKSON AND CO., SEEDSMEN, NURSERYMEN, AND FLORISTS,
1, WATERLOO PLACE, EDINBURGH.

ONE GUINEA OFFERED FOR THE HEAVIEST POTATO PLUM.

(See page 30.)

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PREFACE.

It affords me pleasure in submitting to the Patrons and Promoters of Agriculture and Horticulture, the following deductions on the mysterious subject of Potato Failure; confident, from varied experiment and observation, that I have arrived at a solution of the Problem. I have attempted to establish new principles of cultivation; and I trust, distinguished cultivators will test these principles, and unite in bringing this subject out of its present confusion. I would also ask the co-operation of every Cottager who has a garden. They possess ample facilities for producing and proving healthy new seedling varieties of the Potato, upon the simple principles which I have attempted to demonstrate; and such experiments are calculated to interest and teach their Children, at an early age, the most useful lessons on the Vegetable Economy and the Cultivation of the Soil.

15, Leopold Place,
Edinburgh, *March*, 1845.

DEDICATED

TO THE

CULTIVATORS OF THE POTATO;

WITH THE SIMPLE REQUEST, THAT EVERY ONE WILL CUT SOME

LATE POTATO SEED BEFORE THE EYES SPRING;

OR IF THEY ALLOW THEM TO PASS

THAT DORMANT STAGE,

THAT THEY WILL SPRING WHOLE POTATOES AMONG MOULD,

EITHER WITH OR WITHOUT BOTTOM HEAT,

UNTIL THE STEMS ARE STRONG

AND WELL ROOTED;

THUS TO PROVE BOTH DORMANT DISSECTION,

AND POTATO PLANT SUB-DIVISION, AS EXPLAINED IN

THIS TREATISE, ERE THEY PRONOUNCE

A DECIDED OPINION ON THE RESEARCHES

OF THE AUTHOR.

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THE

POTATO **PROBLEM** SOLVED.

Organic Disease has become Inherent to the Potato.—The fact that there is Organic Disease in the cultivated varieties of the Potato is now so universally admitted, that it may be unnecessary to dwell upon it. The oldest living Agriculturists admit, that in their early days they cut their Seed Potatoes, and threw them into heaps, usually a few weeks before planting them. They were careless about how they had been stored in Winter; careless about the time and method of cutting the seed; and they never thought of change of seed. Their land was roughly prepared, and yet they knew not of failure. Moreover, they admit, that with similar treatment now, failure would be increased four-fold. Although greater attentiou has been bestowed, of late years, upon Potato Cultivation, by superior pulverization of the soil, and change of seed, yet we can annually trace very considerable failure in various districts of the country, both in the field and in the Potato Pit. Even in the most genial seasons, were such failures and blanks in the fields added together, the quantity so lost, might, if preserved, have been sufficient to supply the families of our parochial poor.

Disease in the Potato is not only acknowledged at home, but it ranges over the continents of Europe and America.

It is quite obvious, that a Potato, which has in its component parts even the taint of mortification, cannot be wholesome food for mankind. It therefore becomes important, for the health of both man and beast, and especially for the comfort of the poor, to discover, if possible, the vital cause of this disease; and the remedies will be the more easily resolved. Considering, however, that this subject has occupied the attention and study of the most distinguished cultivators of the soil, for the last ten years, without a solution of the apparent mystery, I would, with the greater diffidence, submit my views and evidence for consideration.

The Primary Cause of Organic Disease in the Potato, elucidated from Comparative, Historical, and Experimental Evidence.

1*st*, *Comparative Evidence of the Cause of Disease in the Potato.*—If a Vine, or almost any tree of the forest, or plant of the garden, be pruned, or wounded through the bark, during the Spring season, when cultivators usually dissect the Potato for seed, the sap will flow out from the wound so abundantly, that the plant or tree will soon become exhausted and fruitless. Were this process continued, for successive Springs, upon the Vine for instance, I believe it would ultimately perish.

The scientific Horticulturist and Forester, therefore, prunes or dissects the generality of forest

trees, garden plants, tender exotic bulbs and tubers, during their dormant winter repose.

It may, however, be remarked, that trees, &c., exposed to have their wounded vessels filled with water, and expanded by frost, ought to be pruned when the leaf falls in Autumn, or in March, immediately before the sap rises in Spring.

The Potato, however, being protected in Winter, may be cut at any time during its dormant repose. But it is contrary to the dictates of Nature, to dissect it at the *only stage* of its annual life, when we know that other plants bleed excessively if wounded. It is even more unnatural still, when it is observed, that at that bleeding season, an isolated Potato tuber has not the same advantage of a plant with roots, for again filling the empty bled vessels.

In speaking of the propagation of plants by eyes, Dr. Lindley, in his celebrated work, " The Theory of Horticulture," observes (page 193), that " the only species very generally so increased, are the Potato and the Vine." " In order to insure success in this operation upon the Vine, it is only uecessary that the *eye should be dormant.*" Here, had the learned Professor of Botany been writing " The Theory of Agriculture " (which the Agricultural world would hail with delight), he might have been led by the same analogy to state, that, " In order to insure success in this operation upon the Potato, it is only necessary that the eye should be dormant."

Such comparisons as these indicate, that the Potato should be cut for seed in Autumn, or before the bleeding season of Spring, as by so doing it will

not, more than the Vine, suffer from loss of sap afterwards.

This system of Potato cultivation, so plainly established by the analogy of Nature, may be termed Dormant Dissection.

It is, however, important to bear in mind, that this vital Spring season, when wounded plants bleed, soon passes away. Again, when the buds of the Vine and the Potato have so far extended as to elaborate the sap, and return it down the stem, for the extension of roots and woody fibre, the Vine and the Potato may be severely cut, if there are only living eyes left to keep the sap in circulation; and the wound will not bleed as before. Thus, when Horticulturists neglect to prune Vines before the bleeding season arrives, they allow them to remain until the young shoots have started into growth, when they prune them with safety. I believe that this natural law, which operates upon stems, branches, and seeds, simultaneously affects every root and fibre; hence the cause of frequent failure, in transplanting plants at the bleeding season, compared with Autumn and advanced Spring.

Comparative evidence thus brings out another rational system of Potato Cultivation, which may be characterized, Potato Plant Sub-division.

2*d*, *Historical Evidence of the Cause of Disease in the Potato.*—Historical evidence appears also to coincide with comparison, in proving, that this vital Spring cutting, this maltreatment of the Potato, has weakened its constitutional vigour. It having been already observed, that Agriculturists were formerly in the habit of cutting their Seed Potatoes a few weeks before planting; they also planted them

earlier than we now do, and consequently, must have dissected them generally about four to six weeks earlier than the current practice now is, when of course the Potato was nearer its state of repose; hence failure was not then known. It is a well known fact, that Seed Potatoes, from late moor land, or even those which have been late of planting on any land, make superior seed to early planted Potatoes. The Potato, like other vegetables, requires a natural time for rest. Late planted Potatoes are thus not so early excited the following Spring as those early planted, and the former will not bleed so freely as the latter, if all are cut on the same day.

This may in some measure account for less total failure, since more attention has been bestowed upon procuring seed from late districts of the country.

I admit, that there are advantages derived by judicious change, of all kinds of seed, from one particular soil and climate to another; but, in the case of the Potato, it is of greater importance still, "that the eye should be dormant."

The common practice of the Horticulturist adds another historical proof in favour of "Dormant Dissection." He usually plants a few Potatoes late in the season, which he finds make the best seed. He plants such late seed *early*, before they are excited to bleed in cutting; consequently, although worn out garden land is the most unsuitable for a sound crop of Potatoes, the gardener seldom complains of failure.

I have met with many an old brother Horticulturist, who has pointed out naturally weak varieties

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of the Potato, which he has cultivated for many years, without change of seed, or change of garden. If the seed with him is not planted early, it is dissected when well sprung in the *small* pits, for seed stock, and therefore approximating either to "Dormant Dissection," or to "Potato Plant Sub-division." I believe, that the history of the cultivation of one of these healthy old varieties, by an old observant Horticulturist, would alone establish more rational principles of cultivating the Potato.

In common field culture, the seed is taken from large heated pits or bings, partially sprung, or overgrown with long white drawn shoots. In the latter state, these virgin shoots are torn away, with a large amount of the tuber's sap. They are then dissected in heaps, during their most vital spring. The sap that ferments out of their mangled vessels gathers at the centre of each wound into a nucleus of putrefaction. Heated, wrinkled, and sapless, they are then planted, clothed with the rudiments of putrefaction; and that often among dry burning dust and hot dung.

I have examined, in fields of diseased Potatoes, many a weak germ, lingering, and drawing its nourishment from a putrefied set, till it died, or produced roots for its own support. Can a crop thus produced be free of the elements of mortification?

Curl was the first stage of disease in the Potato, and the precursor of "dry rot" and "wet rot" (the two characteristic titles of the disease in the Potato). "Curl" and "dry rot" appear in dry seasons, chiefly, perhaps, from the loss of sap, at the open vessels, rendering the germ weak and "curled," and the set "dry," void of sap.

Curl and wet rot, on the other hand, are produced apparently by the effects of wet land, or wet cold seasons, operating upon the set, and surcharging the empty bled vessels with cold unnatural sap.

It is thus quite possible, that were all the mysteries connected with Potato failure exhibited in the full light of physiological and chemical science, they could be demonstrated.

From the nature of the constituent parts of the Potato, it is more susceptible of putrefaction than a turnip, or many other vegetable substances. It being therefore evident, that the diseased Potato is liable to mortification, if the first process has commenced, even in the forenoon of planting, and certain drills left uncovered till the afternoon, the point of kill or cure may very soon be turned, or may rest with the weather, soil, and vitality of the set afterwards to testify.

It is thus easy to account for dry parts of a field failing, and of wet portions of the same field succeeding, in dry seasons; or, under contrary agency, of wet land failing, and dry parts of the same field succeeding; even of one drill failing, with stable yard dung, while the next drill, planted with the same stock of sets, and manured with ashes, should succeed.

Every point of historical evidence may thus go to confirm, that the sap, oozing out of the mangled vessels of the bleeding tuber, acted upon by peculiarity of atmosphere, temperature, condition of soil and manure, once passing into the putrefactive state, at the centre of the cut plane, mortification may eat into the set so quickly, that unless the

efforts of the germ, to reproduce its species, enable the roots to extend into the soil for other food, failure must inevitably be the consequence.

3*d*, *Experimental Evidence of the Cause of Disease in the Potato.*—When practically engaged in the cultivation of the soil, seven years ago, and honoured with a Premium from the Highland and Agricultural Society of Scotland, for other experiments on the Potato, I selected three pecks of equally *diseased* Potatoes, and performed the following experiments with them, on a piece of ground equally manured:—

Experiment on Common (Bleeding) Dissection.—In this experiment, the seed was pitted in the common way, and cut at the usual (bleeding) season. They were partially diseased when cut in Spring. The ground was very light, dry, and sandy. Many of the sets failed with "dry rot," and the rest grew so weakly, that the return was only at the rate of nearly six tons per acre of diseased Potatoes.

Experiment on Dormant Dissection.—In this experiment the seed was cut in November, and immediately stored in an old stable, among peat-mould; they were not so much diseased as the whole ones in Spring. There were only four of the sets covered with blue mould, the rest being healed over, bright white, and hard. The blue moulded ones did not grow; but all the others grew vigorously, producing much taller plants, and larger foliage, than the former. The crop was later than

by bleeding dissection or sub-division, and produced at the rate of eleven and one-half tons per acre, of larger and healthier-like Potatoes.

Experiment on Potato Plant Sub-division.—In this experiment, the seed was preserved in the common way, removed to a vinery in March, buried among mould, watered abundantly, aud when sprung six to eight inches, each large Potato was sub-divided into from nine to twelve plants, having *one* rooted stem, with a small set to each. These were dipped in puddle, and planted ten inches apart, at about an angle of 45°, with their tops to the east. (Other experiments, however, suggest, that the roots and Potatoes should be exposed to the south (or as near that point as practicable), with the tops northward.

The result of this experiment was an earlier crop, by about three weeks, than by dormant dissection. The tops were regular, but not so vigorous. The Potatoes were of very equal size, smaller, but much more numerous, than by either bleeding or dormant dissection. Although, by this sub-division, the peck planted fully double the length of drill, on equal portions of the ground being cleared, Potato Plant Sub-division yielded fully thirteen tons per acre; that is, more than double of bleeding dissection, and two and one-half tons more than by dormant dissection.

The Nucleus of the Cause of Potato Failure.—Let the thinking cultivator weigh the comparative, historical, and experimental evidence adduced, with the analogy of Nature, and with every instance of past failure, and I doubt not but he will

come to the conclusion, that it is contrary to reason as well as Nature, to cut the Potato at the only excitable bleeding season of its annual life, when other plants suffer more or less, if wounded. The sap in the Potato, as well as in every other living vegetable, is constantly in circulation; but, of course, more stagnant in Autumn than in Spring. Every servant-maid is aware, that in scraping Potatoes, they blacken her fingers, and sparkle with juice much more in Spring than in Autumn. Let any one take from a bing, or pit of Potatoes, in Spring, a part of a Potato which has been split by the fork in lifting, and observe how the wound is healed over, more impervious to insects than the natural skin, and the eyes generally more boldly sprung than any whole one. These sets will grow well when spring-cut sets from the same stock will fail. This alone is surely conclusive evidence in favour of Dormant Dissection.

The cause of such sets sprouting stronger may be accounted for from the fact, that the small portion of thick sap and carbon, expended in healing the Autumn wound, may leave the internal structure of the Potato more free for the early admission of carbonic acid gas, which is the first agent to render the sap fluid, and to start vegetation. Thus, when the heat and moisture of Spring acts upon the dry dormant Potato, the carbon becomes partially changed into carbonic acid gas, and the sap becomes more thin and active. Cut the Potato then (as is usually done), and it will bleed like a cut honeycomb, till the ends of the vessels become sapless, and so inert, as to fold over each other like the side of an overworn sponge. If

the eye has been started, in the pit, before the Potato is cut, the rootless sprout will very soon wither away. The whole set, in this stage, becomes soft and shrivelled; and if it is either too small, or deeply tainted with mortification, it may not recover from this exhausted stage; but when sufficient vitality remains, the set again becomes blown up, and full of spent sap, by the chemical change of its remaining elements; and the eye starts again, to live or die, according to the favourable or unfavourable agency of the surrounding soil, manure, and atmosphere.* In plant sub-division, however, the whole Potato, and its numerous progeny of well-rooted plants, that rush from every eye, take up the whole economy of the sap in its vital circulation; and though the tuber be cut into small pieces, if they have a well rooted plant to each, they will not bleed as before. The stem then acts as a pump, to draw up the sap from the set, returning it quickly to the roots, exciting them to re-embrace and feed upon the soil as before; and so soon as the roots again catch the soil, and the stem draws food from the air, vegetation will proceed till leaves unfold in the light; when, the sooner the set decays, the better for the productiveness of the plant.

Bleeding Dissection.—In discussing various sys-

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* In other instances, especially with over-ripe seed, when the inherent sap flows off, the carbon remains fixed, and the set continues for a time hard and healthy like, but the eye never springs. Dry rot in this case decomposes the set.

tems of cultivation, it is of importance to apply a distinct title to each, which may be universally understood. I would, therefore, suggest the above, as the proper characteristic of the present system of Potato Cultivation, which I trust will soon become obsolete.

Improved Cultivation of the Potato.

1. *Dormant Dissection.*—Dormant dissection may be safely performed upon the Potato, so long as the bud in each eye keeps from springing; the best time, however, being in Autumn. The time of springing depends much upon the variety, time of ripening, and method of storing in winter. I have seen Potatoes in small pits, and late moorland districts, keep dormant till April. As the dormant season, however, is already far spent, I trust not a day will be lost in obtaining seed from late districts. Let the moor farmers drive in their dormant seed now, in mild weather, to the market, and they will assuredly find buyers.

Let purchasers cut them immediately, and store them past in narrow pits, or spare sheds, mixed with a little peat mould, or fresh earth, till planting time. By this means they become healed over, ready for immediate growth when planted, and thus proved in the pit in place of the field.

2. *Potato Plant Sub-division.*—I need not recapitulate my reasoning from natural analogy and the experiments already narrated, which, I hold, distinctly bring out two new improved modes of Potato Cultivation.

Having briefly explained the first, by showing

how the seed can be prepared when dormant, and planted in Spring, with the certainty of a regular crop, I shall endeavour to render practicable what I shall in the mean time term Potato Plant Subdivision. Considering that the season is already far advanced for the first system, I have the greater hope, that the following will be extensively adopted this season. It may, at first sight, appear to be intricate and expensive, but experience will bring out its simplicity, and the saving of seed alone will pay for extra labour. Let the stable-yard dung be either carted to a sheltered situation in the potato-field, for manure to form a nursing-bed, or let it be spread wide, so as to afford a slight temperature, in a dry sheltered part of the straw-yard. Cover the surface with turf to keep down the steam, then a layer of four inches of peat earth, leaf-mould, or loam; above this pack a layer of whole Potatoes, with the crowns up, and four inches of mould alternately, till the bed of earth and Potatoes be three or more feet in depth. The surface may be covered over with fresh litter as it comes from the stable. They may thus remain till they are pushing up between each other. I have planted such Potatoes several feet sprung, and had a capital crop; but would prefer them, for convenience in the field, from four to six inches in length. It will be observed, that every stem will be furnished with many rootlets, consequently a very small set is quite sufficient to feed the stem till these roots again lay hold of the soil, and the leaves expand into the light, when the sooner the set decays the better. Every large Potato may thus be dissected into eight or ten sets, one stem to each, in place of

two to four sets only, and thereby realize a saving of half the usual seed. They ought to be cut into open baskets; and while the cutting proceeds, the basket should stand in a tub of thin puddle, composed of soft water and sifted peat earth, cow dung, and clay; or the lightest of the field mould. This puddling is little trouble, but it is of great advantage in feeding the young spongeal roots, till they lay hold of the soil. They may be either planted with the spade or the plough.

If the land has been manured in Autumn, the best way is to lay them in every third furrow; but this would require a turn-reast plough, as the young plant should be laid with the top northwards and the root to the south. This is not indispensable; but I have proved, by experiment, that it is an advantage. The only reason that I can give for this, is, that when the plant lies at an angle, with the root to the south, the roots and the Potatoes receive more benefit from the sun, and are thus rendered larger and of finer quality, than when the Potatoes are overshaded with leaves.

Should they be planted in drills, and manured in the common way, I would give a preference to the turn-reast plough (although the double one will do well). I would draw the drills sloping to the north, and put in the manure. Two planters should then carry the basket between them, planting a row each. I would prefer a person following the planters, covering them slightly with a hoe at first, the plough to follow, on the same south side, when the plants appear above ground. By this practice, of having all the roots and Potatoes on the southmost side of the drill, a turn-reast plough can add earth to the

roots and tubers as they extend to the south, without injuring or disturbing them, as in the current practice.

It ought to be well known to the cultivator, that the roots or feeders of the Potato Plant all proceed from the very bottom end of the stem; and that all the runners, on the other hand, that bear Potatoes, grow from the buried part of the stem above the roots. I have buried long healthy plants of the Potato perpendicularly, and found them unproductive; the feeding roots being, I presume, out of the reach of the sun and air; because similar stems, laid nearly horizontal, and covered slightly, produced abundant returns, although the stems were less luxuriant in some instances.

The nearer the buried part of the stem approximates to a horizontal position, when planted, the more acute is the angle, where the stem rises perpendicular to the air and light; and the circulating sap can be thus checked, more or less, and thrown into tubers, in place of leaves and over-tall stems. It is necessary, however, to keep up a proportionate equilibrium of leaves, roots, and Potatoes. Thus, weak varieties, on poor land, may be planted more upright, while vigorous sorts, that grow too much to straw, on rich land, may be laid in shallow drills, with their tops down the drill if required, to check the sap, and excite the production of additional Potatoes from the buried stem. The elements of rich soil, and the exuberance of luxuriant leaves, roots, and stems, may be thus concentrated to the production of increased crops of Potatoes in place of Potato straw.

3. *How to Produce Two Crops of Potatoes in one year by Plant Sub-division.*—It must be at once perceived, that by starting the whole Potatoes early, in heat, sub-dividing and early planting out, the very earliest crop must be obtained, for allowing time for a successive field crop. In garden culture, if the drills are made to run east and west, and each row protected by a board or slate, tile, &c., say six inches high, on the north side of the plants, sloping to the south, such protection will be found to throw off the perpendicular frost, and overabundant moisture of Spring, and to concentrate the sun's rays. Moreover, I have found, that the sloping board or slate, bending the Potato Stem, checks its upward growth, and renders it earlier. Such protection might be found, by the Horticulturist as well as the Cottager, very useful in protecting early crops, such as Pease, Cauliflower, Cabbage, Kidney Beans, &c.

In producing a second crop of Potatoes, of course, it is only necessary, that there be plants nursed in some late corner of the gardeu, or field, which may have been transplanted occasionally, always removing the small young tubers. If these are puddled over and immediately planted, when the first crop is removed, there ought to be ample season, even in every early district of Scotland, for a late crop for seed or cattle. It may here be remarked, that in common field culture, by subdivision, a crop planted at the usual time, will be ripe several weeks earlier than by common or bleeding dissection; consequently, a little exertion on the part of the cultivator, might afford still more

time for other after crops, such as Rape, Turnip, Cabbage, Bokhara Clover, Tares, &c., for forage, or White Lupines, Mountain Spinage, New Zealand Spinage, &c., to plough down for manure. I am of opinion, that were the seeds, especially of the latter, sown in May, in a warm garden, and the plants puddled over, and transplanted three feet apart, after early Potatoes, it would cover the land well, and enrich it when ploughed-in green.

I may also observe, that by sub-division, Potato plants may be advanced in any spare part of a field, ready to grow a late crop on land which has been well fallowed and drained, thus doing entirely away with a lost crop by Summer fallow.

Whole Potato Cultivation.—The tubers of the Dahlia, Anemone, Alstræmaria, Ranunculus, and most other tuberous plants, are furnished with only about one or two eyes to each tuber, whereas the Potato, for wise purposes, is thickly studded over with living eyes, plainly intimating, that man is not to waste the food provided for him, by planting a whole Potato, when an eye of it will make as good a plant. I have planted whole Potatoes, of all sizes, and have found out, that small ones produce many slender stems, and yield small Potatoes only. Large whole sets, on the other hand, produce so many strong stems, that they cover the ground all around, and thereby exclude the air from their own roots and tubers. The tubers are thus rendered irregular in size, and deficient in quantity and quality; and, moreover, there is a very great waste of seed in planting. In addition to the above objections, it often happens, that a whole old set does not

die away when the plant finds other support; but that it takes up the whole economy of the plant to keep it alive; as there is seldom a young Potato produced, where the old set remains in life at lifting time.

On Growing Potatoes from Stems without Sets.—I have sprung whole Potatoes in a heated Vinery, taken three successions of stems from the eyes, and afterwards dined upon the old tubers. The stems were afterwards puddled, and nursed among mould, till well rooted, when they were finally planted out, as directed in Potato Plant Sub-division. In planting rooted stems without sets, I found it advantageous to keep the top above ground. When covered, the stem grows weakly, or dies; whereas a similar stem, with a small set to it, will push up through the ground vigorously; and I have always found such more productive. With great care in nursing and planting the stems, a Cottager may thus grow a good crop, and feed the pigs with the old Potatoes, in place of planting them; but, so far as my experience goes, I cannot recommend stems without sets, unless they be seedling Potato Plants.

Remarks on Autumn Planting.—The reason that Autumn planted sets frequently succeed well, arises chiefly from their being cut at a proper season. I have found, however, that the sets are liable to be eaten by insects. Whole Potatoes are not so liable to be destroyed by insects; but, as in Spring planting, they produce too many stems. If the land is damp, by Autumn planting, it becomes too firm for Potatoes, and the crop is apt to turn out irregular and

blanky, from the effects of insects, rot, and frost. When, however, the land is dry, and free of insects, and the locality not exposed to very severe frost in Winter, Autumn planting, with Autumn dissection, is highly commendable.

The Proper Size of Potatoes for Seed, and Method of Cutting.—From sufficient experiment on this subject, I am convinced, it is a great loss to grow Potatoes from small seed. The larger the Potato, the larger and more productive is the general structure of the plants from the eyes of it. In dormant dissection, I would invariably throw aside, for cattle, one-third of the root end of the Potato, as useless for proper seed, and cut the remainder in the usual way, as much downwards from the crown as convenient, having at least one eye about the middle of each set, and the set about an inch in thickness opposite the eye. In sub-division again, one-half inch in thickness opposite the eye is enough, especially if the stems are strong and well rooted. I consider it is highly advantageous to obtain seed not too well ripened, from new or moor land.

Storing Potatoes.—Bleeding is the vital cause of disease in the Potato, but their constitutional vigour is also impared by bad treatment in storing, &c. They are cuffed with the fork in lifting, tossed into the cart, and out of the cart, more like stones than liviug vegetables. It should always be borne in mind, that Potatoes should be handled more like eggs than stones, both for the sake of their affording wholesome food and good seed. They are very easily bruised; and bruises give out putrefying gases,

that soon dissolve the whole mass into rottenness. They should, if possible, be lifted dry, and stored into narrow pits, on the surface of dry ground. They ought to be partially mixed with peat mould or dry earth in pitting, and covered on the surface with the same. Straw should never be laid next to the Potatoes, for if rottenness commences, straw is sure to rot also, and increase the mass of putrefaction; whereas mould will act as a preservative. They should not be immediately covered thick over with earth, as is usually done; but ought to sweat a week or ten days, with only a slight covering of litter, or Potato haum, to keep the rain out. For late table use, they should again be stripped when they begin to bud, and turned over, removing any rotten ones, and bruising the tops of the buds. They should again be allowed to sweat, and treated as in the first pitting. It always ought to be remembered, that the Potato is a living vegetable, and in whatever stage it exists, it gives out less or more heat. They should never be stored in large heaps, without facilities for ventilation in suitable weather.

I would suggest, that long pits might be more successfully ventilated, by having triangular wooden pipes, made of three narrow boards, to rest close on the top of the ridge of Potatoes, and perforated with holes on the flat side, in contact with the Potatoes, so as to receive the heated air, to be carried off by little chimneys rising above the pit. The condensed air would thus readily pass off, as it became expanded by the heat of vegetation. Dr. Weir, of Galashiels, is very successful in preserving table Potatoes till an advanced season, by storing them in barrels among sawdust.

I have found those left in the garden-ground, where they grew, and also those preserved in small lots among peat mould, produce a much better crop than the same stock from a pit or bing. I would therefore urge, that Potatoes for seed ought to be stored in small lots, or very narrow pits, well ventilated, and that they should be mixed with a considerable portion of dry peat mould, from the vicinity of undecayed bog oak. Such preservative mould invigorates weak seed, more then leaving it in the ground. It is a slovenly system to leave seed Potatoes in winter exposed to insects, mice, and frost, and the laud untilled where they grow. I have found ferns have the effect of preventing mice, by first covering two inches with mould, then a few ferus, mould, &c. A little soot, mixed with mould, through the pit, also prevents worms and small insects from boring the Potato; but I have not yet discovered what effect it has on the seed, &c. Our Agricultural chemists might surely suggest something to mix with, preserve, and check the growth of Table Potatoes, such as salt mixed sparingly with the mould, &c.

Remedies.

For the Disease in the Potato.—It is an object of the greatest national importance, that the Potato should be again restored to its primitive wholesome state and vigour; that more productive varieties should be brought iuto being, and improved cultivation extended over the country, so as to meet the

wants of the growing family * of industry in our land.

There might be an immediate union of purpose between our great Agricultural Societies, Landed Proprietors, Farmers and Gardeners, to make the Potato an object of universal attention for five years to come, say till 1850. Were this recommended by Agricultural Societies (or even by Government itself), and their sincerity shown by such premiums as the following, the remedies might be expected to be soon discovered.

1*st*, In the event that the whole British family of the Potato is found to be tainted with incurable disease, Government might send out a Botanist to South America for the original species, and distribute it to the London and Caledonian Horticultural and other Societies, in order, that by scientific impregnation, and continued reproduction from the true seed (or plum), they might produce to the whole kingdom healthy and productive new varieties of the Potato.

2*d*, The Royal Agricultural Society of England might offer a premium of Fifty Sovereigns, in 1850, for the most valuable New Seedling Variety of the Potato, adapted for field culture—each competitor to deliver two stones of the Potato in October, 1849, accompanied with a sealed note of address, bearing a motto outside, corresponding to the motto for the

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* It is not expedient for us to wait, till perhaps the three kingdoms are at once visited with a season of failure, such as Scotland felt some nine years ago.

Potato. The seed to be equally dissected, during the first week of November, and each lot stored separately among peat mould. The two stones of each variety, to be carefully divided between two members at a distance from each other, whose land should be of different qualities, and carefully planted during the second week of April, in drills three feet apart, and one foot between each set, and to receive the best cultivation throughout the Summer. They should be lifted during the first week of October, weighed on lifting, and their respective qualities chemically tested. The individual who receives the prize should be bound to deliver, on demand, one-fourth of his stock to the English Society, one-fourth to the Highland Society, and one-fourth to the Society in Ireland, at 10s. 6d. per stoue. These to be divided among members, at cost price (one stone weight to each), according to the order of application, or by lottery.

3*d*, Again, were the Highland and Agricultural Society of Scotlaud to offer £20 in 1846, and £30 in 1847, for the heaviest imperial rood of the old White Don Potato ; with an explicit accouut of the time of cutting, planting, and method of cultivation. The ground to be measured, and each lot to be lifted and weighed, under the inspectiou of three witnesses, one of which to be appointed by the Society.

Let the evidence of the witnesses be given at the bottom of the farmer's account of cultivation, with all their siguatures, and forwarded, along with a sample of the crop, to the Secretary, the second week of April, for the respective premiums of October, 1846, and 1847.

4th, The Royal Agricultural Society of Ireland might offer a premium, in 1845, of £10, for the heaviest "Cup" Potato, and £10, in 1846, for the heaviest Potato of any new kind, with the method of cultivation. Premiums like these, if open to the three kingdoms, would be sure to call forth much interesting competition, and useful information.

How easy would it be for every farmer to turn his Potato crop into a field of experiment, by cutting a portion of one stock of seed every succeeding month, from the time of lifting till the season of planting, and by varied systems of sub-division, &c., establish correct principles to guide the cultivator.

If we have found the cause of failure, we are sure the remedies are within our reach, that may yet render the Potato *doubly* productive. Every Potato Apple that hangs upon the "shaw," contains a multitude of embryo varieties, many of which may be superior to any in cultivation.

In humbly attempting to direct *immediate* attention to this *primary* source of improving the Potato, I hereby offer a premium of ONE GUINEA for the heaviest Potato Plum produced by hybridization,* and delivered free, in October first, at the shop of Messrs. Dickson and Co., 1 Waterloo Place, Edinburgh.

How to Grow a Full Crop of Potatoes, the First Year, from the Apple.—I cannot better introduce this subject, than by quoting from the "Quarterly Journal of Agriculture," vol. viii., p. 281, the fol-

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* The inexperienced in hybridization are referred to p. 34.

lowing notice by Mr. Syme, Schoolmaster, North Berwick, of a crop of my production :—

" Owing to the partial failure of the Potato crop for several years past, it became an object of importance to try experiments, with the view of restoring the constitutional vigour of that excellent esculent. Last year, Mr. Arthur noticing a field of thriving Potatoes, of sorts in this neighbourhood, bestowed considerable pains in crossing (hybridizing) the strongest and most approved varieties in the field, and afterwards carefully collected the seed. The seed thus collected was sown early this season, and the plants thus produced were in due season transferred to new ground, on which Potatoes had never been grown. The crop, which covers more than a quarter of an acre, has the most promising appearance ; the stems being nearly as strong as the best fields in the neighbourhood grown from set.

" From the pretty extensive scale in which the experiment has been made, and the scientific manner in which it has been conducted, it seems well deserving the attention of the Agriculturist, as a great number of new and important varieties may be obtained, no two stems exhibiting the same characteristics."

The same season that the notice which I have just quoted was made, I received the Silver Medal, for fifty-two varieties of them, which I exhibited at the Highland Society's last Show at Dumfries. Through the kindness of my employer, I had an opportunity of renting land, and performing the experiment on my own account. I had new land broken up and cropped, at considerable expense,

and I lifted, in Autumn, about the best crop in the Lothians. The only mistake I made, was planting them too thick, otherwise the Potatoes would have been much larger than the common size. The produce of every promising plant was gathered by itself into a bag, and a great number of sorts given to friends to prove. I find, however, few farmers will be troubled to prove and grow a number of small lots separately, unless they are sure of their superior merits beforehand, or be of their own production. Having then entered a more commercial field of Agriculture, I have not had sufficient facilities for carrying out the experiment, consequently the great bulk of my crop was given to the cattle, or afterwards lost. I selected one hundred varieties, which a distinguished Agriculturist was to grow for me; had them planted and lifted under my own inspection, the first year, and reduced to fifty very promising sorts. They were, however, lifted in mixture the second year, by mistake. I would, therefore, urge upon every cultivator, who grows seedlings, to prove them personally.

I am, however, glad to know, that there are a number of promising varieties from that experiment, in careful hands. I would, in particular, refer to the Messrs. Imrie and Sons, Seedsmen, Ayr, who possess about thirty very productive sorts; and to Andrew Howden, Esq., Lawhead, by Haddington, who speaks very highly of several varieties which he cultivates.

It is well to know, that in seasons of scarcity, we may consume all our Potatoes for food, and yet have luxuriant fields of the Potato from the Seed-plum alone. In order to make it practicable for

every Cottager, as well as Farmer, to meet such a season, or to produce improved varieties, I will endeavour to describe the scientific method of producing the best seed. Excellent seed may be obtained, and superior varieties produced, from Plums gathered from a healthy field of Potatoes; but I am convinced, from experiment, that hybridization has a powerful effect in invigorating the seedlings.

The Wheat, Barley, Oat, Bean, and Potato, are surely still more worth experiment than the loveliest flowers, and most delicious fruit, that have been brought into being by the skilful Horticulturist.

But, to proceed with the Potato. Let the experimentalist select six or twelve superior healthy varieties, placing one large tuber of each into a warm situation, covered over with mould. When the eyes have sprung four or five inches, select the strongest one from each tuber, with a good set to it. Place each set into the middle of a good sized flower-pot, covering it about four inches with peat earth, and rotten dung. Bury the pots, to the brim, in a warm situation, till the stems grow six inches to a foot in height. Then turn the pot upside down, the stem of the Potato passing between the two middle fingers of the left hand. The pot may then be lifted away, leaving the ball of mould entire. All the young Potatoes will be observed outside the ball, and must be carefully removed. If the old set still exists, it must also be removed. As the plants are thus individually prepared, they must be planted out, in rich soil, at the bottom of a west or south aspect wall, and well watered. Each plant should be trained to a single

stem, upon the wall, and freely supplied with liquid manure, in dull showery weather.

When the truss of flowers appear, they should be thinned out with scissors, leaving only one or two of the strongest. The moment they are *beginning* to expand, the experimentalist must cautiously open up each flower, and, with watchmaker's tweezers, or small scissors, remove the five little balls, or anthers, that contain the fertilizing pollen, leaving untouched the centre stigma, which stands in the middle of every flower, like the head end of a pin. The following morning, a full-blown Potato flower should be procured from a field, and the pollen of its anthers gently dusted over the top of the centre stigma of the prepared flower. This should be repeated the following morning also. By this simple process, which any child may perform, hybrids, or mules, may be produced, between any two plants of natural affinities. If young Potatoes are found to be produced near the surface, they should be early removed; and, the plant being well grown, not producing Potatoes, and only one or two Plums, will, by attentive management, produce enormous sized Seed Plums (see premium, page 30), each of which will produce some hundred new varieties of Blacks, Whites, Reds, &c. As a guide, however, to the discovery of the best sorts for hybridization, the name of the sort that produced each Plum, with the sort used in crossing, ought to be distinctly labelled, and preserved till they are proved. The seed must be kept free of mice. When the Plum is ripe, preserve it from frost, till it is shrivelled, when the pulp, &c., may be mixed with peat mould till sowing time.

Should the cultivator not possess seed by hybridization, I would urge upon every one, to select a few Plums in Autumn, from healthy Potato Plants in the field, and to grow at least a few rows of seedlings in the field or garden annually. The wealth that may yet flow from the production of superior new seedling Potatoes, is as much within the reach of every Cottager who has a kale yard, as the skilful Gardener or Farmer. I will therefore endeavour to simplify, how a full crop may be produced from the seed the first year, by the humblest cultivator.

If the experimentalist is in possession of an old window, or glass frame of any kind, so much the better; let him build a turf bed the size that it will cover. If not, let him build an upright bed, or box, with a wall of turf, about three to four feet in height, sloping to the south. The bed may be of any length or width, compared with the various sizes of common garden frames, according to the quantity of seed to be grown. A small bed, of three or four feet across, will grow some thousand plants, and may suit the cottager. The bed may be filled in February either with leaves, tan bark, flax dressings, meal seeds, and horse dung, or the latter by itself, which may be had in exchange for ashes.

When filled eight inches from the brim, a layer of turf must be put upon it, with the green side down, to keep the steam from rising; then four inches of peat mould, and rotten dung, or fine rich mould. Sow the seed upon this in rows, four inches apart, and tally each sort of seed distinctly. Height-

en the wall with more turf, and add a little mould between the rows as the plants advance.

The bed may be very simply protected by a sash, made of a few cross rods, covered over with peeled straight wheat straw, so regulated and tied to the rods, as to carry off the greater portion of the rain that falls, and yet to admit light between the straws; or it may be covered with cotton cloth, and the composition for it is sold in every seed shop. Another sash, more thickly thatched with straw, must be used, to keep out frost at night, and to cover during coarse weather.

As the plants grow, they should be freely exposed in fine weather, and gently watered. When they advance to about six inches in height, remove them by handfuls, and puddle them all over with fine peat mould, mixed up with water to the consistence of cream. Put each handful separately into the middle of a rhubarb leaf, with the tops out, and thus return them into the bed, or to some warm sheltered spot. The puddle precipitates to the roots and feeds the plants. About the beginning of May, or when all danger of frost is past for the season, they may be planted out. Let a bucket of puddle, of sifted peat, or leaf mould and water, be again prepared. Take the bundles out of the decayed leaves, and tease the roots carefully apart, removing all the prematurely formed small tubers. Let them be again puddled all over, and returned into fresh leaves, and baskets, ready for planting. The puddle remains on the leaves till rains wash it off; and it has an excellent effect, both in preventing the effects of the sun's scorching rays, and in

protecting from frost. I have had seedlings thus transplanted, in sunny weather; and the first shower left the leaves clean, and always of a dark green colour. The plants, by this time, with me, were a foot to eighteen inches in length, and nearly the thickness of a writing quill. Those that I laid horizontal in rows, were more productive than those whose stems were perpendicular. If the land is good, I would generally plant strong seedlings during May, two feet and a-half apart between the drills, and one foot in the drill. They should be planted carefully, with the spade, in shallow drills, one after the other, with their tops to the north, and covered within an inch of the top. They might be planted in the field, by drawing shallow drills; and while one laid plants against the north side of the drill, another could follow with a hoe, and slightly cover them. The plough would do the rest of the work, as they grow. In lifting such a crop for family use, they will be found to divide themselves into three classes: Dons of sorts; Blacks of sorts, and Watery-like ones of sorts. After a little experience, there is no difficulty in knowing the quality by the leaves, plants, and tubers. I dined upon my seedlings, from the apple, the first year, for successive weeks, and never tasted better Potatoes.

It is important to know, that we could thus save some hundred thousands of bolls of the Potato, in seasons of scarcity.

Every cultivator is, less or more, a judge, almost at first sight, of the proper characteristics of a good kind of Potato. A short stout square stem, with few branches, but broad dark green leaves, is to

me an index, that the variety will draw more food from the air than the roots, and consequently economize the constituents of the soil. The root should not have any superfluous abortive runners, but have a good sized Potato at every runner. The runners should also be stout and long, not to crowd the Potatoes at the root, and the tubers ought to be numerous and equal in size, round, flattish, and rough on the skin, " dry," and white when dissected. Many valuable varieties of the Potato may, however, yet appear, of various characteristics.

I will not occupy space with any comparison or description of the named varieties in cultivation, confident, that the growing energy and enthusiasm for experiment will, in a year or two, bring new improved ones into being, superior to those now in cultivation.

In conclusion, I do not hold this treatise out as a full analysis of Potato failure and *perfect* cultivation. It remains for intelligent cultivators to put my humble ideas and experiments into practice, weigh and correct them in the broad balance of extended experience, and thereby develop the ample treasury, which the vegetable arcanum and faithful soil have yet in store for the industrious man.

APPENDIX.

APPENDIX.

ON IMPROVING WASTE LAND,

AND

DEVELOPING THE INTERNAL RESOURCES

OF

THE COUNTRY.

In the preceding pages I have attempted to throw light on a mysterious subject, intimately associated with national prosperity.

When we consider, that by renewing the constitutional vigour, and improving the cultivation of the Potato, its acknowledged utility may be extended in improving vast tracts of waste land, and developing the internal resources of the country; it may not be out of place to consider, in an appendix, the most profitable and practicable means of carrying this desirable object into early operation.

1. *On Reclaiming Land by the Cultivation of Potatoes.*—It is a well known fact, that there is no crop so well adapted, as a first agent, in reclaiming land, as the Potato. It luxuriates among decomposing turf or rough vegetable fibre; and its cultivation and growth are powerful auxiliaries in

pulverizing the primeval soil. In preparing such land for a Potato crop, it is perhaps not so commendable as many consider, to have the land *both* pared and burned, as it is difficult to get good permanent pasture established afterwards.

Should the land be very wild with heath, the roughest of it might be mowed off and charred with clay, to scatter over the light peaty portion of the ground; or the heath might be burnt upon the ground, without paring. The ground thus prepared in Summer, or early Autumn, should immediately be thrown into "lazy beds," from five to six feet in width, with an alley of about two feet between each bed. The turf should be pared off the alleys first, and laid in hollow places of the bed, which should be roughly levelled.

One spade and shoveling of mould should then be thrown over the bed covering the rough herbage. By this *early* covering, the woody fibre becomes vegetable food by Spring, and the surface well pulverized and dry for a good Potato crop. Of course, it is of the greatest importance, that sufficient drainage be provided to carry the water from the furrows. The land that produced grassy forage will require no manure for the first crop, but such as produced heath only will produce a superior crop, with a mixture of equal portions of burnt clay, gypsum, and guano.

In planting the sets (prepared either by "Dormant Dissection" or "Plant Sub-Division"), I would either draw shallow drills across the beds, eighteen inches apart, and cover them with the foot, &c., or plant them at the same distance with the spade, if the land is very rough and turfy.

When the land is, however, ultimately intended to be drained for alternate husbandry, every alternate furrow *only* ought to be deepened, in adding successive layers over the beds, as the crop advances in early Summer, thus preparing for the introduction of tile, &c.

In lifting the Potatoes for this purpose, the shallow furrows may be filled well up, to form the crowns of the ridges; and, it is probable, that in most cases, the stones could be economically removed with strong forks, as the lifting proceeds, casting them along one side of each intended drain.

When successive green crops are required to pulverize and clean the land, Turnips should succeed the Potatoes, and when the land is mossy, it should, if possible, be sown down by the third year with Oats, Beer, or Barley. I should consider the following the best mixtures of grass seeds for such land :—

¾	Bushel	Evergreen Ryegrass.
6	lbs.	Timothy Grass.
2	lbs.	Fiorin do.
4	lbs.	Cowgrass Clover.
2	lbs.	Alsike do.
4	lbs.	White Dutch do.

When, however, the land is merely to be planted for shelter and timber, the furrows ought to be equally deepened to remain open. The mould also ought, in this case, to be kept as well upon the beds as possible, in lifting the Potatoes, and the young forest trees planted in rows, along the bed, at least three feet apart both ways. It may be

found economical to grow a row of Turnips, with guano, for a year or two, down the middle of each bed; and Cabbage, &c., might also be cultivated in the furrows.

2. *On Reclaiming Land by the Cultivation of Timber.*—In travelling over the United Kingdom, and more especially the wilds of Scotland and Ireland, the enthusiastic Agriculturist blushes to behold immeasurable tracts of country, blotched with stagnant morasses, barren heath, and frowning hills, without the uplifted arm of a tree to check the current of the storm that bounds over the mountains, laying waste the minor efforts of improvement on adjacent plains. He beholds the necessity of some great national effort, in overmantling these hills with extensive forests, to produce shelter for crops of corn. Were such planting carried into immediate effect, he can rationally contemplate (thirty or forty years hence) myriads of rural villages arise, and golden corn crops wave, where (without shelter) the heath may only bloom. In the one case, he can picture the increasing ratio of internal prosperity and independence; in the other, he may soon discover a season of war, or depression in manufactures, without food at home, money in our pockets, or power of steam to draw from an enemy the necessities of life. By all means encourage manufactures, but let the land we live in, like her industrious families, be placed in independence!

Our enlightened Government might encourage proprietors to make an immediate effort, in planting a large portion of the high land annually, till the whole country becomes sheltered, and successful

cultivation ascends the very sides of lofty hills, and penetrates into the recesses of the woods. Past experience, and present demand, indicate, that Timber is a most profitable crop; and the splendid forests that now overtop the once barren moors of Blair Atholl, feeding numberless cattle in their shade, prove, that high land may produce as much, or even more herbage, with the trees, as without them. This *double gain* is a subject yet in its infancy. The New Cow Parsnip will produce *early*, abundant, and wholesome food for cattle, both in the shade of trees, and on wild moss land.

3. *Suggestions for Joint Stock Companies Purchasing and Planting Moor Land.*—The value of immediate shelter on the hills is of such importauce, and the spirit and power of Joint Stock Companies so manifest, that their agency might also be brought into operation in the safe investment of improving our native land. The current Joint-Stock Companies of the day *may* yield a *present* return, but they are speculative, and being chiefly constructed by works of art, they are subject to decay and loss; but a £5 share in a young forest, in the name of an infant son, may yield him a handsome sum to commence business with at the age of thirty! I would, therefore, say, let Juvenile Waste Land, and Forest Joint-Stock Companies be immediately formed, and liberally supported by the children of prosperous families. Moor land can frequently be purchased for a mere trifle, and well planted with young Larch, Pine, and Oak, &c., for little more than £1 per acre.

4. *Charity Joint-Stock Forest Companies* might also be found most effective in seasons of national distress. Had the money lately subscribed for the famishing weavers of Paisley, for instance, been given them in the form of wages, for draining and bedding the large tracts of waste land near to it, which were then in the market, they would not have been humbled by eating the bread of idleness, but would have returned an equivalent to the subscribers and the nation.

In minor instances of distress, in a village for instance of forty unemployed families, where £20 have been subscribed for their relief, How far will 10s. go with a famishing family?

Offer the £20 as a premium to the individual or company who will give forty men work for the longest period, and at the highest rate per day; and be assured, instead of 10s. given to any family *in idleness*, ten times ten will be held out for *labour*, by patriots who can appreciate the honour and *profit* of such a prize. Let there be no more *idleness* iu our land; no more want of labour, where even the best cultivated fields, in the vicinity of towns, *may be improved* by deep spade trenching, draining, or mixing of soils.

5. *Atmospheric Drains.*—In "Loudon's Gardeners' Magazine," for July, 1837, I threw out an idea, "that the tunnels, formed by drain-tile, might be employed in conducting large quantities of atmospheric air into the earth, which might be the means of saving manure, and increasing the fertility of the soil." Subsequent experiment still farther confirms the idea. It must appear evident, that on dry land

in particular, the luxuriance of the crop *above* a recently formed drain, does not arise from the land being *drier;* it proceeds from the more *copious admission* of *atmospheric food* to the *roots* of the crop. The air of the atmosphere contains the most essential elements of the food of plants; hence, large leaved crops, such as clover, *feed* on the atmosphere, and *enrich* the soil.

Suggestions for Experiments on Atmospheric Draining.—In draining land, at every furrow, the whole of the drains in a field might be atmospherically connected, by a few cross or angular drains, to one grand centre at the middle of the field. A fire, lighted for a short time over the centre vacuum, so arranged, as to derive its atmospheric food from the drains only, would soon draw the air from the drains, admitting dry or damp air according to the state of the atmosphere, or as the land or crop required.

I consider, however, from experiments, that still greater advantages would result from the application of a powerful air force-pump, at the grand centre, from which, *night* or *day*, *dry* or *moist air* could be forced through every drain, finding its way through the pores of the soil, to the roots of the crop, and thereby increase its productiveness. Of course, it would be a very simple matter to clay and close up the open ends of drains during such experiments. We require only to discover the real value and principles of applying the boundless treasury of air and electricity to agriculture, to render it a more productive and interesting science.